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eight feet gave no evidence of man, although yielding remains of animals to the bottom indicating the early accessibility of the cave. In general, the depth of cave earth was less than this. The human relics were abundant but not varied in kind and implied but one type of civilization. Potsherds were by far the most abundant, some decorated with incised lines and a few colored. Only a few implements were found. Human bones were occasionally present. Of the vertebrates identified by Professor Cope there were three batrachians, six reptiles, nine aves, and sixteen mammalia, thirty-three species in all. Members of each of these groups were found beneath the relic-bearing layer at depths varying from six to fourteen feet, twenty-two instances being tabulated. Of the shells, eleven species were identified by Pilsby; eight instances of occurrence below the human layer being tabulated. These data show abundantly the accessibility of the caves before the incursion of man.

The author's conclusions are: "*First*, That no earlier inhabitant had preceded the builders of the ruined cities in Yucatan.

"*Second*, That the people revealed in the caves had reached the country in geologically recent times.

"*Third*, That these people, substantially the ancestors of the present Maya Indians, had not developed their culture in Yucatan, but had brought it with them from somewhere else." T. C. C.

New Evidence of Glacial Man in Ohio. By PROFESSOR G. FREDERICK WRIGHT. Appleton's Popular Science Monthly, December 1895.

The "fresh discovery recently brought to light," which constitutes the subject of this article, is, in reality, a discovery made more than three years ago. It therefore antedates the recent controversy respecting the evidence of glacial man in America which the author revives and makes his point of departure, and on which he strives to bring to bear this evidence as something recent. The central point of that controversy was the untrustworthiness of the old methods of observing and interpreting the supposed evidence of glacial man. The sharp criticisms which provoked it were sorely needed, as the event has shown, to reform the loose methods then prevailing. This "fresh discovery" belongs to the ante-reform period, and is to be weighed accordingly.

Announced as such, it deserves consideration, for it is one of the better class of examples of the old method.

The nucleus of the article consists of a statement by Mr. Sam Huston, a surveyor and collector, under date of August 13, 1895, of the finding, over three years previous to that date, of a rude stone implement, in a gravel terrace near Brilliant, on the Ohio River. The terrace ranges from 65 to 80 feet above low water, and consists of interstratified sand, fine gravel, and clay in small quantities, all with rare exceptions cross-bedded. "Indian mounds and intrusive burials occur at numerous places on the terrace, but the stratification and the cross-bedding of the sands and gravels of it are such that intrusive burials or excavations cannot be made without leaving evidence so distinct as to be readily seen, and at the face of the excavation a slip or talus is easily detected." The flint implement was found "under about eight feet of undisturbed cross-bedded stratification, only the point of the implement showing on the perpendicular face of the excavation. The condition of the stratification in all of the superincumbent eight feet, which was closely examined by me, was such as to convince me that the implement was not intrusive, but had been deposited with the remainder of the material of the terrace" (Huston).

Mr. Huston's observations may fairly be accepted as excluding intrusive burial by Indians, but they do not seem to exclude intrusion by modes which do not notably disturb the stratification, for these do not appear to have been in mind at the time of his observations and would not naturally obtrude themselves upon attention. These neglected modes of intrusion were discussed at the meeting of the American Association for the Advancement of Science at Madison, but this was some time after Mr. Huston's observations were made, and he obviously could not avail himself of the suggestions there offered. Particularly applicable to the present case is the mode of intrusion offered by the decay of tree roots, as this is not only a forest region, but the elevation of the terrace, the porosity of the sand and gravel, and the low water level especially invited the deep penetration of large roots. Allowing a hundred years for a generation of trees, there falls within the conventional historical period of 6000 years, the possibility of sixty successive forests. This may serve to suggest in a rude way the large number of root-tubes which may have been opened by decay and afterwards filled in relatively modern times. It is a well-known fact that decay commonly starts at the surface and proceeds down-

ward, and thus invites filling from above. It is furthermore often the case, perhaps indeed the rule, that the bark of roots decays more slowly than the interior, thus preserving the tube for a time after it is open to intrusion from above. In the growth of the trees the roots heave the earth about the base of the trunk, and this raised position is obviously the first to collapse on the initiation of decay. Now there are special reasons why implements were somewhat more likely to be lost about the base of a tree than elsewhere, for its shade was naturally sought for rest, for shelter, for sedentary work, such as the making and repairing of implements, for the gathering of nuts, for climbing, and for a multitude of incidental reasons. Missiles, though not in point in this case, were likely to be arrested by trees, especially as they were often directed at game in them. The mounds and intrusive burials mentioned by Mr. Huston imply that this was a frequented spot, and that lost and discarded implements would be not uncommon. Articles lost at the immediate foot of a tree would be liable to fall into the stump cavity on its decay, or to be trodden into it, and to follow down the root tubes as the rotting progressed. With the prolonged decay of the centuries the organic matter disappears in such porous beds, and the signs of intrusion become exceedingly obscure. It would be a rash geologist who would claim that he had detected all of the multitude of refilled root-tubes of a possible three score or more of generations of forests in an inspection of a gravel bank, unless he most assiduously searched for them. It is no detraction, therefore, from the assumption of fair competency or perfect honesty on the part of the observer, to withhold complete confidence in the inspection of Mr. Huston, so far as it is supposed to exclude intrusion by the more occult methods of which this is a type, though his observations may fairly be assumed to exclude intrusion by burial, to which his attention was directed.

Following the statement of Mr. Huston, the author discusses the vital question of the age of the gravels. He calls attention to a line of terraces resting on rock shelves about 300 feet above the river (*i. e.*, 220 feet above the implement-bearing terrace). These bear granitic pebbles, and are appropriately referred to the glacial period. They occur at intervals along the Ohio up to its head, and follow the Allegheny River so far as it skirts the glacial border. He notes the opposing views entertained respecting the age of these, rejecting that which involves two glacial epochs separated by the erosion of the gorge in

which the lower terrace lies. He maintains on his own part that the evidence of two distinct glacial epochs is insufficient, and holds that "the deposits of glacial gravel upon the three-hundred-foot rock shelf have been produced partly by an extensive filling up of the Allegheny gorge as far as Pittsburg and somewhat below, and lower down by the effect of the Cincinnati ice-dam, which set back the water up to this level, and is sufficient to account for many of the facts. Under this view these high-level deposits would coincide approximately with what Dana calls the 'Champlain epoch,' during which there was considerable depression of land at the north, the influence of which may have been felt as far south as the latitude of Pittsburg."

The rejection of interglacial erosion, and the introduction of the Cincinnati ice-dam as an agency seems to the reviewer to very greatly weaken the case. The unfortunate ice-dam hypothesis was originally urged as specially applicable to the high-level terraces of the upper Ohio and its tributaries; indeed it may be said to have had in them its *raison d'être*, but investigation has shown that it is altogether untenable. The author himself has been forced to abandon it for the upper region where the phenomena are conspicuous and have been competently studied. It is safe to say that the same fate will befall it in its application to the terraces farther down the river, for they are of the same order and have the characters of river terraces and not those of ponded-water terraces. Any interpretation hung on the ice-dam hypothesis is quite certain to have an early fall. Excluding this, it is either necessary to suppose that the valley was eroded to a depth of more than 220 feet (either in drift or in rock) before the floods of the later glacial epoch formed the lower terraces, or to regard these lower terraces as remnants of the high-level filling cut into terrace form in later times and more or less *re-worked* on the surface in the process. If the supposed high-level filling really occurred in the time of the Champlain depression, to which the author refers it, very much the largest part of all the erosion that has taken place since must have occurred before the implement-bearing terraces were formed, and, accepting the general estimates of post-glacial time favored by the author, this might not impossibly bring their formation this side of the reign of the Pharaohs.

But in reality the author assumes that the great interglacial erosion took place (though he has not yet come to call it interglacial, and he would probably still wish it understood to be a reëxcavation) for he

says that every stream emerging from the glacial area is marked by the lower system of terraces, and some of these enter the Allegheny-Ohio valley in that portion which the author admits to have been filled up to the high-level terrace plane, and the low terraces could only have been formed after the requisite deep excavation. It is also implied in the following, which calls for consideration on other grounds: "But whatever may be the difference of opinion about the age of these high-level gravels, there is no disagreement about the glacial character and relatively late age of the lower terraces along the Ohio River such as occur at Steubenville and Brilliant." In a loose sense it is true that the glacial character of these lower terraces is agreed upon, but this is a case in which no looseness is admissible. In a general way it may be said that the gravel deposits out of which these terraces have been cut were formed by the late glacial waters, but only a portion of them are strictly primary and retain the original surface of the deposits. Many of them are secondary in greater or less degree. Their upper plains were not formed in glacial times, but were fashioned by erosion out of the earlier deposits, and were *reworked* in the process. The extent to which the Ohio River then reworked its bed may doubtless be judged by what it is doing now. The vertical range of the material which it is now working over is several times the depth at which the implement was found. It is quite necessary therefore to know whether the upper part of the Brilliant terrace is primary or secondary. There are terraces on the river above and below it that reach 120 and 130 feet above low water, while the implement-bearing terrace only reaches eighty feet. Here is a difference of a round third of the maximum height. If the difference is due to erosion it seriously compromises the case, for the date of the fashioning of the terrace might be quite late, and the implement might have been introduced in the reworking incident to it. The difference may, of course, be in part, or possibly altogether, due to original difference in height. But this must be *demonstrated* to make the case good. If it is merely assumed that the terrace surface is original, the conclusion dependent on it suffers all the uncertainties of the assumption.

The nature of the implement is discussed in the article, and the opinions of several archæologists respecting it are given. It is pronounced to be one of a very ancient form which has, however, always continued in use.

The author indicates his views of the environment of the time as

follows: "In closing I cannot refrain from a few remarks concerning the conditions of life at that period, especially since the prolonged visits which I have made to the retreating ice front in Alaska [a month in midsummer] and in Greenland [two or three weeks in August] have rendered it so much easier for me to believe in glacial man than it would have been without those experiences. The neighborhood of the ice border during the glacial period was probably not an uncomfortable place in which to live." And again, in respect to conditions unfavorable to relics—"When we reflect, also, upon the completeness with which the habitations of the modern Indians have disappeared, we need not be surprised at the total disappearance of the habitations of glacial man. Nor is it strange that well-accredited discoveries of his implements have so rarely been made in the undisturbed gravel which gives us the surest evidence of his great antiquity. Naturally, the cautious inhabitant of that time would have been somewhat careful about venturing down into the river valleys, whose terrific and periodical floods were depositing the terrace gravel." And yet we are expected to believe that these terrific, fear-compelling floods made a deposit of sand, fine gravel, and clay in which, "except for two or three feet on top, only rare pieces of gravel occur of more than one half cubic inch in size" (Huston). T. C. C.

Fossil Sponges of the Flint Nodules in the Lower Cretaceous of Texas.

By J. A. MERRILL. Bull. Mus. of Comparative Zoölogy at Harvard College, Vol. XXVIII., pp. 1-26, 1 plate, July 1895.

This paper is the first contribution to the minute structure and organic remains of the flints found so abundantly in the Caprina limestone of the Lower Cretaceous of Texas. Mr. Robert T. Hill, in several preliminary papers, has described their geological occurrence.

The studies set forth in this paper were based upon a few nodules brought to Cambridge (Mass.) by Mr. E. E. Cauthorn, from a quarry west of Austin, Texas.

"The hardness of these nodules," our writer says, "is often greater than that of glass. . . . In shape they are spherical, cylindrical, or flat; and in size they vary from two inches to a foot or more in diameter. The color is a dense black, with white or gray spots mixed irregularly through it, varying in size from microscopic to that of a pin-head. These spots are generally replacements of organic remains,